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Role of chromospheric partial ionization on the dynamics of kink unstable flux ropes

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Recent observations performed by space missions (SDO, Hinode) prove the existence of mini-filament eruptions within the solar chromosphere that could be connected to the formation of chromospheric jets and spicules. The growth of the helical kink instability within these structures is responsible of the onset of magnetic reconnection and lead to explosive events occurring ubiquitously in the lower solar atmosphere. Numerical studies of low-lying loops neglect critical physics in the form of partial ionization, which can lead to enhanced reconnection rates and a more efficient heating and particle acceleration. Here we perform high resolution multi-fluid simulations of kink unstable flux ropes to elucidate the role of partial ionization in modifying the kink process. The complex charge-neutral coupling in our model includes ionization, recombination and radiative losses. Partial ionization leads to a faster onset of the non-linear phase of the kink instability, whose reconnection rate could be consistent with those estimated by observations of the smaller chromospheric filaments. The magnetic energy lost with reconnection is distributed differently between fully ionized plasmas and partially ionized plasma cases, with a larger increase of internal energy and temperature associated to partial ionization and additional heating terms, such as the frictional heating, resulting from multi-fluid dynamics. Partial ionization effects lead to a faster kink instability and the release of larger quantities of thermal energy, which is reflected by a more explosive chromospheric flux rope dynamics.

Primary author: MURTAS, Giulia (Los Alamos National Laboratory)

Co-authors: Prof. HILLIER, Andrew (University of Exeter); Dr SNOW, Ben (University of Exeter)

Presenter: MURTAS, Giulia (Los Alamos National Laboratory)

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